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METHOD FOR APPROXIMATING A MEASURING TIME AND CORRESPONDING APPARATUS

The invention relates to a method for determining a measuring point in time (t_M), at which a measured value is to be produced by a field device of process automation technology, wherein the field device communicates its measured values at certain communication points in time (t_K) over a field bus, following a query from a central control unit for its measured values. Additionally, the invention relates to a corresponding apparatus. The field device is, for example, a fill level measuring device. The measured values are, for example, fill level, pressure, viscosity, density or a pH-value of a medium. The field bus is, for example, a Profibus" field bus.

Field-devices/measuring devices e.g. for measuring and/or monitoring the fill level of a medium in a container are produced and sold by the assignee. These measuring devices deliver their measured values, or, in general, the chemical or physical process variables, usually on a field bus for further processing. Desirably, the measurement data are as current as possible, so that they reflect the current state of the medium. This is, above all, relevant, when the frequency of the fetches or queries lies in the order of magnitude of the possible measuring frequency. Consequently, the measured data should be produced just shortly before the communication. For this, however, it must be known, when the query will occur through the field bus. This point in time depends e.g. on how many measuring devices are connected to the field bus. If the number of measuring devices is increased, then the time spacing between the queries becomes greater. Also, the configuration of the whole system can be changed, so that the spacings vary. Thus, there are no rigidly predetermined time spacings. This problem arises especially, when the query comes over the field bus from a central control unit and when the field devices do not communicate their data independently or at least do not know about the remaining happenings on and around the field

bus. If the queries occur in sufficiently large time spacings that, in the meantime, plural measurements are possible, then it can be desirable to reduce energy consumption by avoiding the taking of measurements which will not be fetched anyway.

Therefore, an object of the invention is to determine approximately the point in time of a query from the central control unit, in order to coordinate therewith the production of the measured value therefor. For such purpose, a method and a corresponding apparatus are required.

The object is achieved according to the invention with reference to the method by the following features: That, on the basis of at least two communication points in time (t_K, t'_K) the following communication point in time (t_f) is at least approximately determined, and that, on the basis of the approximately determined communication point in time (t_f), the point in time (t_M) of measurement is determined. The point in time of measurement (t_M) should, in such case, lie as shortly as possible before the approximately determined communication point in time (t_f) and, consequently, before the reporting of the measured value. Thus, from previous communication points in time, future queries are inferred, e.g. by averaging of the previous points in time. The method thus assumes that queries have already taken place; the method thus cannot be applied e.g. for the start-up of a system. Advantageous for the method is, following possibly every communication, to estimate the following communication point in time (t_f) using the directly preceding communication point in time (t_K). If, for example, the number of measuring devices changes, or if something in the total configuration changes, then the spacing between queries will also change. The measuring point in time (t_M) must, in such case, be so determined, that the spacing to the communication point in time (t_f) is as small as possible. The measuring point in time (t_M) should, however, also be so placed, that the measured value can also actually be communicated. Thus, when it is known, that the production of a measured value

can take different lengths of time, then this is to be considered.

An advantageous embodiment provides that the measurement point in time (t_M) is also communicated with the measured value. This is important in the evaluation of a time series, in order to be able to associate the measured values with the points in time at which they were determined. The communication of the measurement point in time (t_M) is, above all, important, when the measurement points in time have varying time spacings. Thus, this communication enables also a time evaluation of the measured values.

An embodiment provides that, from at least one time span (A) between at least two preceding communication points in time (t_K, t'_K) and a preceding communication point in time (t''_K), the following communication point in time (t_f) is approximated. Thus, first it is calculated, that e.g. between two preceding queries there was a time difference of x seconds, i.e. $A = |t'_K - t_K| = x$ seconds. In line with this, the following communication point in time (t_f) is the point in time (t''_K) of the directly preceding query, plus x seconds. In such case, a point in time (t_K, t'_K) can be identical with the point in time (t''_K), starting from which the following communication point in time (t_f) is approximated, i.e. $t'_K = t''_K$. A further possibility is to determine the time span (A) between three queries. For approximating the following communication point in time (t_f), this spacing (A) can either be added to the point in time of the next to last query or the spacing (A) is divided by 2 and added to the point in time of the directly preceding query (t''_K). Other variants of forming the average value are possible. For instance, also only one time span can be used for approximating the next following communication point in time (t_f).

An advantageous embodiment provides that at least two time spans (A_1, A_2) between, in each case, at least two preceding

communication points in time (t_{K1}, t'_{K1}, t_{K2}, t'_{K2}) are calculated, that an average value (M) is formed from the time spans (A_1, A_2), and that the following communication point in time (t_f) is approximated starting from the average value (M) and a preceding communication point in time (t''_K). At a minimum, thus, three queries - i.e., for example, $t'_{K1} = t_{K2}$ - must have taken place, so that between, in each case, two queries, the time spans (A_1, A_2) can be determined and the average value (M) can be formed. By the forming of averages, the advantage is obtained, that smaller fluctuations of the time spans drop out. In such case, an optimum can be found for the number of values used for forming the average value.

An advantageous embodiment provides that, in the case where the time span (A_b) until an approximately determined communication point in time (t_f) is smaller than a smallest value (K), the communication point in time (t_f) is approximated starting from this smallest value (K), with the smallest value (K) being determined from the minimum time span (A_{min}) possible between two measurements one following on the other, when technical constraints are taken into consideration. The case can arise that the queries come too quickly for the field device. In such case, the technical constraints of the field device must be addressed. The measuring rate can thus not be predetermined by the central control unit, but must, instead, be set by the field device itself.

An advantageous embodiment provides that, in the case where the time span (A_b) to the approximated communication point in time (t_f) is greater than a limit value (G), the communication point in time (t_f) is approximated starting from the time span (A'_b), which was used for the approximation of the preceding approximated communication point in time (t_f), wherein the limit value (G) represents a boundary between a time span between queries in a normal communication cycle and a time span in a disturbed communication cycle of the control unit. Thus, a problem is that e.g. in the case of field/measuring devices, a

parametering can be performed, i.e. parameters are newly set by a parametering unit. Such a process takes, for the most part, markedly longer than the spacing between normal queries by the central control unit. If such a parametering is performed on a measuring device, then, in the case of a field device that follows the measuring device in the query sequence, the query first arrives markedly later. Such an intervention can not be predicted, but must be taken out of the calculation of the following communication point in time (t_f), since it is not to be expected that, right after one parametering procedure, another will follow. Thus to be distinguished is between a normal communication cycle and a communication cycle disturbed e.g. by a parametering. Therefore, if, from the calculations, a time span (A_b) results, which is greater than a limit value (G), then there has entered into the calculation a time span, which has possibly resulted from a parametering or other disturbance of the normal communication cycle. Therefore, calculations should not use this spacing (A_b), since a point in time would result, which would, with high probability, lie after the real query. In the simplest implementation, the time span (A'_b) of the preceding approximation is used for the approximation of the next point in time. However, an arbitrarily determined, standard value can also be used. Usually, the points in time for queries and for parametering differ sufficiently, such that e.g. a statistical evaluation of a multiplicity of time spans between queries yields a limit value (G). This should be performed in an installation on site or by a simulation of the system. Another implementation of this recognizing of a disturbance of the communication cycle is to evaluate the deviation between the calculated and the arisen communication point in time and, in the case of a deviation, which is, in turn, greater than a value to be determined, to modify the approximation suitable for the next communication point in time.

The object is solved with respect to the apparatus by the features that at least one field bus communication unit is

provided, which, in the case of a query from the control unit, communicates at least the measured value, and that at least one output/control unit is provided, which controls the measuring point in time (t_M) of the field device, wherein the field bus communication unit transmits at least the communication point in time (t_K) to the output/control unit. The apparatus thus includes a field bus communication unit - e.g. an ASIC -, which accepts queries from the field bus and determines whether the query is directed to the particular field device. The output/control unit, which can be an appropriate microprocessor, receives reports of the communication points in time (t_K) and starts with them in approximating the following communication point in time (t_f). With that, the measuring point in time (t_M) is then determined and the measuring suitably initiated.

The invention will now be explained in greater detail on the basis of the drawings, the figures of which show as follows:

Fig. 1 a flow diagram for the method; and

Fig. 2 a block diagram of the apparatus.

Fig. 1 shows schematically how the method of the invention works. The smallest value K is derived from the technical constraints. It gives the minimum time span that can lie between two measurings, as dictated by the technical situation. The limit value G gives the boundary between a spacing between communication points in time in a normal communication cycle and a spacing in a communication cycle disturbed e.g. by a parametering. The lengths of these two spacings are sufficiently different that the limit value G can be determined e.g. by a statistical evaluation of a multiplicity of communication points in time. These two comparison values K and G are to be specified before the beginning of the actual process. Then, from previous communication points in time, in each case the following communication point in time is

approximated. In such case, e.g. the spacing between plural points in time can determined and appropriately averaged. Starting from the preceding, last communication point in time, an approximation is then obtained for the following point in time. If the spacing to the next communication point in time is smaller than the smallest value K, then the queries from the central control unit are occurring faster than the process variables of the medium, e.g. the fill level, can be measured. Therefore, the following communication point in time t_f is calculated from this smallest value K, e.g. by adding the smallest value to the last communication point in time t_K. If the time span is smaller than the limit value G, then only a normal query took place and an undisturbed communication cycle is involved. If the time span is greater, then a disturbance has taken place e.g. in the form of a parametering event. Direct consequence of the delay is that the field device would have to communicate a "stale" measured value. Since it is not to be expected that an event would take place right away again, it makes more sense to approximate the next communication point in time t_f, for example, using the data of the preceding approximation, e.g. by using the same time span. Following the approximation of the communication point in time t_f, the optimum measuring point in time t_M is determined, which should lie as shortly as possible before the communication point in time t_f, in order to avoid that the measured value is "stale". At the same time, the measuring point in time t_M should also be so chosen that the measured value can be communicated as immediately as possible upon the query, in order not to produce any delays. This determining of the measuring point in time t_M depends, therefore, very strongly on the intrinsic properties of the measuring device. If this measuring point in time t_M is reached, then the measured value is produced, and, after the query from the field bus, communicated.

Fig. 2 shows a block diagram of the apparatus, with a field bus 5, to which are connected, in this example, three field devices 1 (for example, fill level measuring devices), a central

control unit 10 (for example a programmable logic controller, PLC) and a parametering unit 25 (for example, a computer). The field devices have a field bus communication unit 15 (e.g. an ASIC) and an output/control unit 20 (for example, an appropriate microprocessor). Via the parametering unit 25, for example, parameters can be changed in the field devices 1. The output/control unit 20 is so constructed, that it fixes the point in time of the measurement on the basis of the preceding communication points in time, of which it receives knowledge from the field bus communication unit 15.

List of Reference Characters

1	field device
5	field bus
10	control unit
15	field bus communication unit
20	output/control unit
25	parametering unit